



Production Optimization for Two-Phase Flow in an Oil Reservoir

Völcker, Carsten; Jørgensen, John Bagterp; Thomsen, Per Grove; Stenby, Erling Halfdan

Published in:
Proceedings of the 17th Nordic Process Control Workshop

Publication date:
2012

Document Version
Publisher's PDF, also known as Version of record

[Link back to DTU Orbit](#)

Citation (APA):
Völcker, C., Jørgensen, J. B., Thomsen, P. G., & Stenby, E. H. (2012). Production Optimization for Two-Phase Flow in an Oil Reservoir. In J. B. Jørgensen, J. K. Huusom, & G. Sin (Eds.), *Proceedings of the 17th Nordic Process Control Workshop* (pp. 198). Technical University of Denmark. <http://npcw17.imm.dtu.dk/>

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Production Optimization for Two-Phase Flow in an Oil Reservoir

Carsten Völcker, John Bagterp Jørgensen, Per Grove Thomsen

*Department of Informatics and Mathematical Modeling
Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark*

Erling H. Stenby

*Department of Chemical and Biochemical Engineering
Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark*

Keywords : Reservoir simulation/management, Runge-Kutta, ESDIRK, optimal control, nonlinear model predictive control, adjoint sensitivity.

Petroleum reservoirs are subsurface formations of porous rocks with hydrocarbons trapped in the pores. Initially, the reservoir pressure may be sufficiently large to push the fluids to the production facilities. However, as the fluids are produced the pressure declines and production reduces over time. When the natural pressure becomes insufficient, the pressure must be maintained artificially by injection of water. Conventional technologies for recovery leaves more than 50% of the oil in the reservoir. Wells with adjustable downhole flow control devices coupled with modern control technology offer the potential to increase the oil recovery significantly. In optimal control of smart wells, downhole sensor equipment and remotely controlled valves are used in combination with large-scale subsurface flow models and gradient based optimization methods in a Nonlinear Model Predictive Control framework to increase the production and economic value of an oil reservoir. Whether the objective is to maximize recovery or some financial measure like Net Present Value, the increased production is achieved by manipulation of the well rates and bottom-hole pressures of the injection and production wells. The optimal water injection rates and production well bottom-hole pressures are computed by solution of a large-scale constrained optimal control problem.

The objective is to maximize production by manipulating the well rates and bottom hole pressures of injection and production wells. Optimal control settings of injection and production wells are computed by solution of a large scale constrained optimal control problem. We describe a gradient based method to compute the optimal control strategy of the water flooding process. An explicit singly diagonally implicit Runge-Kutta (ESDIRK) method with adaptive stepsize control is used for computationally efficient solution of the model. The gradients are computed by the adjoint method. The adjoint equations associated with the ESDIRK method are solved by integrating backwards in time. The necessary information for the adjoint computation is calculated and stored during the forward solution of the model. The backward adjoint computation then only requires the assembly of this information to compute the gradients.